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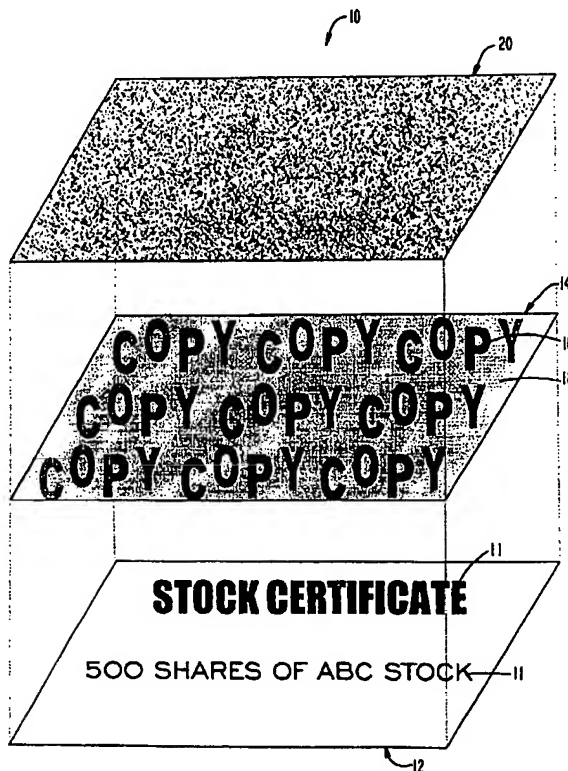
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(71) Applicant: VERIFY FIRST TECHNOLOGIES, INC. [US/US]; 1760 Commerce Way, P.O. Box 2428, Paso Robles, CA 93446 (US).			
(72) Inventor: PHILLIPS, George, K.; 1760 Commerce Way, Paso Robles, CA 93446 (US).			
(74) Agent: BOLAN, Michael, J.; Lyon & Lyon LLP, Suite 4700, 633 West Fifth Street, Los Angeles, CA 90071-2066 (US).			Published <i>With international search report. With amended claims and statement.</i>

(54) Title: VARIABLE DENSITY VERIFICATION

(57) Abstract

A counterfeit-resistant document comprises a contrasting layer (14) and a dynamic camouflaging layer (20) (as shown in the figure). The contrasting layer is highly contrastive and includes a latent message (16) that can be reproduced over a broad range of copy device control settings. The dynamic camouflaging layer is applied over the contrasting layer to suppress the latent message. The visual density of the dynamic camouflaging layer, which comprises a camouflage pattern that is printed in thermochromic ink, inversely varies with temperature. In this manner, the dynamic camouflaging layer is inactivated at room temperature so that the latent message is suppressed on the original document, and activated at scanning temperatures so that the latent message is exhibited on a reproduction of the original document.



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VARIABLE DENSITY VERIFICATION

DESCRIPTIONField of the Invention

5 The present invention pertains to the field of security systems for documents, including more particularly to novel duplication resistant documents and methods of creating duplication resistant documents.

10 Background

 The importance of making documents safe from duplication and alteration is readily apparent. The advent of improved photocopy equipment, particularly high resolution color photocopy equipment, as well as desk top publishing and digital scanning, has provided the unscrupulous with the means for unauthorized duplication of original documents for the purpose of passing them off, with or without alteration, as the original document. The quality of the reproductions obtainable through these means is so good that, it is difficult to distinguish original copies from color reproductions. Even if the duplication is not exact, the reproduction often appears authentic in the absence of the original for comparison. This problem is well-known to the issuers of such original documentation, and considerable attention has been given to find ways and means to prevent unauthorized duplication of such documents by photocopiers or other electronic methods.

 Many techniques have been developed to prevent improper reproduction of original documents. One of the more known techniques is based on the phenomenon that photographic copiers have an element value (sometimes referred to as element frequency) threshold above which the photocopier is unable to distinguish the individual elements of the pattern of for example, halftone printing. In general, a pattern with a low line screen value of large sized elements is more easily reproducible than a pattern with a high line screen value of small sized elements.

In accordance with this technique, a hidden warning message, such as "VOID" or "COPY," is printed in a halftone over a halftone background printed on a substrate. The line screen value of the hidden warning message is selected, such that the halftone elements of the hidden warning message are reproduced when photocopied. The line screen value of the background; however, is selected, such that, the halftone elements of the background are not reproduced when photocopied. As a result, the hidden warning message will appear on duplicates of the original document made by photocopying. This method is also used by reversing the halftones of the hidden warning message and the background such that the elements of the hidden warning message are not reproduced and the elements of the background are reproduced when photocopied or scanned. Known line screen values that are used to print these types of hidden warning messages and backgrounds are, e.g., 65 LPI and 133 LPI, respectively (i.e., a line screen value ratio of approximately 2.)

In addition to selecting differing line screen values for the hidden warning message and the background pattern to allow them to be used to prevent duplication, it is also known to use different respective tonal screen values (i.e., the percentage of ink coverage) can also be selected to differ so that the hidden warning message more easily appears on a reproduction of the original document. Known tonal screen values that are used to print these types of hidden warning messages and background patterns are, e.g., 12% and 10%, respectively (i.e., a tonal screen value ratio of about 1.2).

Because of the disparity between the respective line screen values and respective tonal screen values of the hidden warning message and background pattern, a mere combination of these two techniques would not be effective because the hidden warning message would normally be visible to a casual observer of the original. To minimize the visible appearance of the warning message with this combined technique, the respective tonal screen values are selected so that they are more similar and/or a camouflage pattern

can be printed over the hidden warning message and background to obscure the hidden warning message from a casual observer of the original document. The camouflage pattern may be defined by areas in which dots, lines, bars, or marks have been formed for both the hidden warning message and background pattern, or the background pattern may be defined by a pattern of dots, lines, bars, or marks which are smaller than or larger than those used in the hidden warning message and background pattern, or by areas of complete coverage of a paler ink.

A description of these aforementioned techniques can be found in U.S. Patent Nos. 4,227,720 and 5,197,795.

Another technique and example for creating duplication resistant documents is illustrated in U.S. Patent Nos. 5,271,645, 5,018,767, and 5,193,853, whereby printed line frequencies are printed at specific angles that mis-register with the protocols of electronic color scanners causing a moiré pattern when copied.

While the above techniques have provided some degree of protection of original documents with respect to most copiers, in recent years digital scanners and color copiers have improved substantially. These new color copiers, such as the Canon 700 and 800 series, have made the above techniques less effective in protecting original documents.

By manipulating the control settings on such devices, copies can be made of such original documents in which the hidden warning message does not readily appear on reproductions when some of the most commonly used frequency and element size combinations are used. When the contrast setting of these modern photocopiers are set to the lighter settings or the copier is set to a built-in halftone setting, the resolution of the copier is such that it neither reproduces the lower line screen value/high tonal screen value hidden warning message nor the higher line screen value/lower tonal screen value background pattern. If the line screen value and tonal screen value of the hidden warning message is adjusted so that the lower line screen value/high tonal screen value hidden warning message

is reproduced at a lighter copier setting, both the higher line screen value/lower tonal screen value background pattern and the lower line screen value/higher tonal screen value hidden warning message are reproduced. In both cases, the hidden warning message does not readily appear on the reproduction of the original document, so that a casual observer of the document may not be alerted that the document they have is not the original.

A greater disparity between the respective line screen values and tonal screen values of the hidden warning message and background pattern would allow the hidden warning message to appear on a reproduction of the original document even with the manipulation of the copier. Due to the great disparity, however, presently known camouflage techniques do not adequately suppress the visual appearance of the hidden warning message on the original document. This could result in the original document being rejected as a copy which is not acceptable to issuers of the original.

There thus remains a need to provide a counterfeit resistant and copy resistant original document and technique that effectively suppresses the visual appearance of a hidden warning message on the original document, while at the same time, effectively causing the hidden message to visibly appear on copies of the original, thereby precluding an unscrupulous copyist from suppressing the hidden warning message on a reproduction of the original document by manipulation of the control settings of the copying or scanning device.

Summary of the Invention

The present invention comprises a novel duplication resistant document and method of producing such a document that when reproduced exhibits a latent message.

In a preferred method and embodiment of the present invention, a document comprises a substrate on which a message layer and a camouflaging layer are formed. The message layer comprises a latent message and a background. The contrast between the latent message and the background

is such that the latent message is visible on a reproduction of the document. The dynamic camouflaging layer preferably comprises an environmentally varying ink; such as, thermochromic ink, that is formed onto the substrate as a camouflage pattern. The visual density of thermochromic ink inversely varies with temperature; such that, the appearance of the camouflaging layer is different at room temperatures and photocopying or scanning temperatures.

In alternative preferred embodiments, combinations of multi-tone contrasting layers, vignetted contrasting layers, multi-patterned dynamic camouflaging layers, and multi-spectral dynamic camouflaging layers are employed in accordance with the inventive features of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a depiction of an exploded view of a counterfeit-resistant document according to a preferred embodiment of the present invention.

Fig. 2 is a depiction of a top view of the contrasting layer of the counterfeit-resistant document of Fig. 1.

Fig. 2a is an enlargement of the circled latent image of Fig. 2.

Figs. 3A to 3E are latent messages that preferably employed with the contrasting layer of Fig. 1.

Figs. 4A to 4G are camouflage patterns preferably employed with the dynamic camouflaging layer of the counterfeit-resistant document of Fig. 1.

Fig. 5 is a depiction of a top view of the original counterfeit-resistant document of Fig. 1.

Fig. 6 is a depiction of a top view of a reproduction of the counterfeit-resistant document of Fig. 5;

Fig. 7 is a depiction of a top view of a multi-tone counterfeit-resistant document according to an alternative preferred embodiment of the present invention;

Fig. 8 is a depiction of a top view of a multi-tone contrasting layer of the multi-tone counterfeit-resistant document of Fig. 7;

Fig. 9 is a depiction of a top view of a reproduction
5 of the counterfeit-resistant document of Fig. 7 produced at a first copying device control setting;

Fig. 10 is a depiction of a top view of a reproduction of the counterfeit-resistant document of Fig. 7 produced at a second copying device control setting;

10 Fig. 11 is a depiction of a top view of a counterfeit-resistant document according to an alternative preferred embodiment of the present invention;

Fig. 12 is a depiction of a top view of a vignetted contrasting layer employed in the counterfeit-resistant
15 document of Fig. 11;

Fig. 13 is a depiction of a top view of a reproduction of the counterfeit-resistant document of Fig. 11 produced at a first copying device control setting;

Fig. 14 is a depiction of a top view of a reproduction
20 of the counterfeit-resistant document of Fig. 11 produced at a second copying device control setting;

Fig. 15 is a depiction of a top view of a counterfeit-resistant document exhibiting a multi-patterned dynamic camouflaging layer according to an alternative preferred
25 embodiment of the present invention;

Fig. 16 is a depiction of a top view of a reproduction of the counterfeit-resistant document of Fig. 15;

Fig. 17 is a depiction of a top view of a counterfeit-resistant document exhibiting a discrete multi-spectral
30 dynamic camouflaging layer according to an alternative preferred embodiment of the present invention;

Fig. 18 is a depiction of a top view of a reproduction of the counterfeit-resistant document of Fig. 17;

Fig. 19 is a depiction of a top view of a counterfeit-resistant document exhibiting a prismatic multi-spectral dynamic camouflaging layer according to an alternative preferred embodiment of the present invention.

5 Fig. 20 is a depiction of a top view of a reproduction of the counterfeit-resistant of Fig. 19.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 depicts a counterfeit-resistant original document 10 (in this case, a stock certificate) comprising a substrate 12, a contrasting layer 14 comprising a latent message 16 and a background 18, and a dynamic camouflaging layer 20 comprising a camouflage pattern 22. The substrate 12 is preferably of paper stock. Any material suitable for printing, however, may be used without departing from the scope of the present invention. As depicted, bearer information 11 is printed on the substrate 12. The contrasting layer 14 is printed on the substrate 12 over the bearer information 11, and the dynamic camouflaging layer 20 is printed over the contrasting layer 14.

As shown in Fig. 2, the latent message 16 contrasts with the background 18 and visually appears to a casual observer in the absence of the dynamic camouflaging layer 20. The latent message 16 comprises text, as shown in Fig. 2, but can alternatively comprise any indicia; such as, an image that conveys information to an observer of the original document 10. The latent message 16 and background 18 are each printed as a halftone image. The latent message 16 comprises a pattern of elements with a relatively low line screen value and large element size. The background 18 comprises a pattern of elements with a relatively high line screen value and small element size. In the preferred embodiment, the elements are dots, but can alternatively comprise of lines or marks.

35 The disparity between the contrast of the latent message 16 and the background 18 is, such that, the latent

message 16 visually appears on the reproduction of the original document 10 over a wide range of copying device control settings. Respective line screen values for the latent message 16 and background of 50 LPI and 150 LPI (i.e., a line screen value ratio of 3), and respective tonal screen values for the latent message 16 and background 18 of 8% and 5% (i.e., a tonal screen value ratio of 1.6), result in the consistent visual appearance of the latent message 16 given the present state of the xerographical technology.

10 Figs. 3A-3E, respectively, depict various examples of latent messages 16a-16e that can be formed in the contrasting layer 14, preferably, to enhance the suppression of the latent message 16 on the original document 10. The pattern of the latent message 16 is irregular, and the surface area covered by the latent message 16 is approximately equal to or greater than the surface area covered by the background 18.

The graphics pattern of the dynamic camouflaging layer 20 plays a significant role in camouflaging the latent message 16. In general, the graphics pattern of the dynamic camouflaging layer 20 is preferably formed with a certain level of irregularity to its pattern to facilitate camouflaging of the latent message 16. The more irregular patterns, with a greater diversity of tones or alternating solid/open areas, are the easiest to print and camouflage the latent message 16, but lose some effectiveness when digitally copied. On the other hand, the smoother, more evenly spaced patterns, are more difficult to print without noticing the latent message 16, but are more effective when digitally copied.

30 Figs. 4A-4G respectively depict various examples of camouflage patterns 22a-22g, that can be effectively employed with the dynamic camouflaging layer 20. The camouflage pattern 22 can comprise words such as shown in the camouflage pattern 22e of Fig. 4E. The ratio of the area of the printed markings, to the total area on which the markings are printed, is preferably approximately 50% to

provide a more similar visual appearance between the latent message 16 and the background 18, thereby, aiding in the suppression of the latent image 16 to a casual observer of the original document 10.

5 The ink density of the dynamic camouflaging layer 20 also plays a role in camouflaging the latent message 16. Ink density or color is a sensory perception and can be perceived only in conjunction with light. The light penetrates into the transparent color of the ink film. When
10 passing through the ink, the light continuously strikes against pigments, which, depending on the ink film thickness and the pigment concentration, absorb a greater or lesser part of certain wavelengths of light. When the light rays finally reach the printed substrate surface they are
15 reflected back. After traveling back through the printed ink film, that proportion of the light which has not been absorbed by the ink, exits. It is this part of the light that is perceived by the eye of the observer and forms the assessment basis for color saturation. It is also this part
20 of the light that is optically recognized by electronic devices.

 There is a correlation between ink film thickness and ink density. The absorption behavior of an ink film depends on the hue, the ink film thickness, and on the nature, as
25 well as, the concentration of the printing ink pigmentation.

 Since, however, the color hue for process colors is standardized and the pigment concentration for these colors is also specified within a certain framework, only the ink film thickness remains as a variable which can be
30 influenced.

 The amount of light that is reflected from the surface of the printed substrate can be measured by a GreyTag D19C densitometer to quantify the density variations the eye perceives. Ink density values are expressed as logarithmic
35 numbers. As the logarithmic density values increase, the amount of available light decreases. For example, a density of 0.00 indicates that 100% of incident light is reflected.

 A density of 1.00 indicates that only 10% of the incident

light is reflected. A density of 2.00 indicates that only 1% of the incident light is reflected. This conversion is designed to adapt the density measurement to the peculiarities of the human sensory perception.

5 In general, as the density of the dynamic camouflaging layer 20 increases, the less the light incident on the contrasting layer 14 is reflected back through the dynamic camouflaging layer 20, and the more the latent message 16 is suppressed with respect to the original document 10.

10 Suppression of the latent message 16 furthers the interest of not falsely alerting a casual observer of the original document 10 that it is otherwise. As the density of the dynamic camouflaging layer 20 decreases, the more the light incident on the contrasting layer 14 is reflected back

15 through the dynamic camouflaging layer 20, and the more the latent message 16 is exhibited. Exhibition of the latent message 16 furthers the interest of allowing a copying device to capture the latent message 16, thereby creating a reproduction of the original document 16 on which the latent

20 message 16 visually appears to a casual observer. In light of these countervailing interests, it is difficult, using standard inks, to both suppress a message situated in a highly contrastable pattern of an original document during normal viewing conditions and exhibit the message on a

25 reproduction of the original document. Such is this case, with the latent message 16 found in the contrasting layer 14.

 The dynamic camouflaging layer 20 comprises an environmentally density changing ink, such as a

30 thermochromic ink (i.e., an ink the color and density of which changes with temperature). The thermochromic ink is formulated with heat crystals, which renders the pigment portion of the ink subject to spectral changes when exposed to specific temperature levels. Thus, the thermochromic ink

35 will undergo a visible change in density and color (i.e., hue and/or saturation) when exposed to the proper temperature range. The thermochromic ink, used to form the dynamic camouflaging layer 16, darkens as the temperature

decreases, and lightens as the temperature increases. In general, the darker the ink, the greater the visual density.

Thus, the visual density of the thermochromic ink is inversely proportional to the temperature to which the ink is exposed. The composition and method of making thermochromic inks, and effects thereof, are disclosed in pending Application Serial No. 08/602,243, entitled "Document Security System Having Thermographic Pantograph and Validation Mark," and filed by George K. Phillips on February 16, 1996, which is fully incorporated herein by reference.

Because the visual density of the thermochromic ink is inversely proportional to temperature levels, the color of the dynamic camouflaging layer 20 darkens at or below room temperature, thus becoming more dense and facilitating the suppression of the latent message 16 on the original document 10 during normal viewing conditions; and lightens at temperatures to which typical copying devices subject a document (i.e., scanning temperatures), thus becoming less dense and facilitating the exhibition of the latent message 16 on a reproduction of the original document 10.

The thermochromic ink has a dormant state when exposed to a low-level temperature range, and an activated state when exposed to a high-level temperature range. That is, the dynamic camouflaging layer 20 suppresses the contrasting layer 16 at room temperature, so that the latent image 16 does not visually appear to a casual observer of the original document 10 (shown in Fig. 5); and exhibits the contrasting layer 16 during scanning temperatures, so that the latent image 16 visually appears to a casual observer of a reproduction 10' of the original document 10 (shown in Fig. 6).

Selection of the exact color, reactive properties and graphics of the dynamic camouflaging layer 20 is preferably coordinated with the selection of the contrasting properties of the contrasting layer 14. As the disparity between the respective line screen values and respective tonal screen

values of the latent message 14 and the background 16 increases, the need for graphic balancing complexity and visual density of the dynamic camouflaging layer 20 at room temperature increases. Conversely, as the disparity between the respective line screen values and respective tonal screen values of the latent message 14 and the background 16 decreases, the need for graphic balancing complexity and visual density of the dynamic camouflaging layer 20 at scanning temperatures decreases.

The particular thermochromic ink selected preferably has a visual density at room temperature that is high enough to effectively suppress the latent message 16 on the original document 10; and a visual density at scanning temperatures that is low enough to effectively exhibit the underlying latent message 16 on a reproduction of the original document 10. If the latent message 16 and background 18, respectively, have screen values of 50 LPI and 10% and 150 LPI and 5%, thermochromic inks having a cold visual density level (i.e., a visual density level measured at 60°F or below) between 0.15 and 0.80, and a warm visual density level (i.e., a visual density level measured at 76° or above) between 0.02 and 0.22 measured with a GREYTAG D19C densitometer, are preferably employed. The presently most preferred thermochromic inks, however, are thermochromic inks that have a cold visual density level between 0.15 and 0.35 and a warm visual density level between 0.08 and 0.22.

The exact composition of thermochromic ink is preferably modified to effect the exact visual density changing properties of the thermochromic ink. Ultimately, selection of a preferred thermochromic ink depends on the exact temperatures to which the ink will be exposed and the opaqueness and color hue pigmentation of the ink.

The particular arrangement of the dynamic camouflaging layer 20 is preferably varied to optimize the camouflaging of the latent message 16. The patterns shown in Figs. 4A-4G, to varying extents, suppress the latent message 16 when viewing the original document 10; while exhibiting the

latent message 16 when viewing a reproduction of the original document 10 given the above-mentioned cold and warm visual density ranges.

In alternative embodiments, the environmentally varying ink used to form the dynamic camouflaging layer 20 is a photochromic ink (i.e., an ink the color of which changes with the intensity of light). The visual density of the photochromic ink is inversely proportional with the intensity of light. Under a low-intensity light (e.g., ambient light found in a lit room), the visual density of the photochromic ink, like the thermochromic ink, is high enough that the latent image 14 on the original document 10 is suppressed. On the other hand, under a high-intensity light (e.g., light produced by a copier or scanner), the visual density of the photochromic ink, like the thermochromic ink, is low enough that the latent image 14 appears on the reproduction of the original document 10.

Fig. 7 depicts an alternative preferred embodiment of a counterfeit-resistant original document 50 comprising a multi-tone contrasting layer 52 (see Fig. 8). To the extent the particular aspects of the original document 50 are the same as those of the original document 10, the same reference numerals have been used.

As shown in Fig. 8, the multi-tone contrasting layer 52 has a first contrasting portion 54 and a second contrasting portion 56. The first contrasting portion 54 comprises a first latent message 58 (faintly shown in Fig. 7) and a first background 60. The elements of the first latent message 58 are larger than the elements of the first background 60. Alternatively, however, the elements of the first latent message 58 are smaller than the elements of the first background 60. The second contrasting portion 56 comprises a second latent message 62 (faintly shown in Fig. 7) and a second background 64. The elements of the second latent message 62 are larger than the elements of the second background 64. Alternatively, however, the elements of the

second latent message 62 are smaller than the elements of the second background 64.

The respective line screen values of the first latent message 58 and the second latent message 62 are different.

5 Alternatively, however, the respective line screen values of the first latent message 58 and the second latent message 62 are the same. The respective line screen values of the first background 60 and the second background 64 are different. Alternatively, however, the respective line
10 screen values of the first background 60 and the second background 64 are the same.

For instance, one useful combination is a line screen value of 50 LPI at 25% tonal screen value for the first latent message 58 and 150 LPI at 15% tonal screen value for
15 the first background 60; and 50 LPI at 10% tonal screen value for the second latent message 62 and 150 LPI at 5% tonal screen value for the second background 64. Another useful combination is a line screen value of 50 LPI at 25% tonal screen value for the first latent message 58 and 150
20 LPI at 15% tonal screen value for the first background 60; and 65 LPI at 12% tonal screen value for the second latent message 62 and 130 LPI at 5% tonal screen value for the second background 64. Still another useful combination is a line screen value of 50 LPI at 10% tonal screen value for
25 the first latent message 58 and 150 LPI at 5% tonal screen value for the first background 60; and 50 LPI at 15% tonal screen value for the second latent message 62 and 150 LPI at 5% tonal screen value for the second background 64.

The first contrasting portion 54 has an overall tonal
30 screen value that is more than that of the second contrasting portion 56, and the first contrasting portion 54 appears darker than the second contrasting portion 56. This enhances the difficulty of a copyist's manipulation of the control settings on the copying device in order to suppress
35 the latent message on the reproduction of the original document 50. That is, if the copying device is adjusted to obscure or eliminate the first latent message 58, the second latent message 62 will appear on a reproduction 50' of the

original document 50, as shown in Fig. 9. Likewise, if the copying device is adjusted to obscure or eliminate the second latent message 62, the first latent message 58 will appear on the reproduction 50' of the original document 50, as shown in Fig. 10.

Fig. 11 depicts an alternative preferred embodiment of a counterfeit-resistant original document 80 comprising a vignetted contrasting layer 82 as shown in Fig. 12. To the extent the particular aspects of the original document 80 are the same as those of the original document 10, the same reference numerals have been used.

As depicted in Fig. 12, the vignetted contrasting layer 82 comprises a latent message 84 (shown faintly in Fig. 11) and a background 86. The respective line screen values of the latent message 84 and the background 86 differ and are constant across the vignetted contrasting layer 82. Preferably, the respective line screen values for the latent message 84 and background 86 are 50 LPI and 150 LPI. The size of the elements of the latent message 84 and background 86 differ and gradually vary across the vignetted contrasting layer 82. That is, the tonal screen value of the vignetted contrasting layer 82 varies. Preferably, the respective tonal screen values of the latent message 84 and background 86 varies from 30% and 20% to 15% and 5% across the vignetted contrasting layer 82. The tonal screen value of the illustrated vignetted contrasting layer 82 is preferably varied in steps, producing bands of slightly differing tone. In some applications, however, the tonal screen value of the vignetted contrasting layer 82 can continuously vary. The element size of the latent message 84 and the background 86 shown in Fig. 12 preferably vary horizontally across the original document 80. The element size of the latent message 84 and the background 86 preferably vary in any direction (e.g., vertically or diagonally).

As with the multi-tone contrasting layer 52, the additional feature provided by the vignetted contrasting layer 82 enhances the difficulty of the copyist in manipulation of the control settings on the copying device in an attempt to suppress the latent message on the reproduction of the original document 80. That is, if the copying device is adjusted to obscure or eliminate the latent message 84, at least a portion of the latent message 84 will appear on a reproduction 80' of the original document 80 as shown in Figs. 13 and 14, since the tonal screen value of the vignetted contrasting layer 82 varies.

In alternative embodiments, the element size of the latent message 84 varies across the across the vignetted contrasting layer 82, while the element size of the background 86 remains uniform across the vignetted contrasting layer 82; or the element size of the background 86 varies across the vignetted contrasting layer 82, while the element size of the latent message 84 remains uniform across the vignetted contrasting layer 82.

Fig. 15 depicts an alternative preferred embodiment of an original document 100 comprising a multi-patterned dynamic camouflaging layer 102. To the extent the particular aspects of the original document 100 are the same as those of the original document 10, the same reference numerals have been used.

The multi-patterned dynamic camouflaging layer 102 comprises multiple camouflage patterns, such as the camouflage patterns 22e, 22a, and 22b depicted respectively in Figs. 4E, 4A, and 4B. The multiple camouflage patterns are preferably selected to have differing suppression characteristics. As with the contrasting layers 52 and 82, the multi-pattern dynamic camouflaging layer 102 enhances the difficulty of the copyist to manipulate the copying device control settings in an attempt to suppress the latent message 16 on the reproduction of the original document 100.

That is, because the multiple camouflage patterns provide differing suppression characteristics, it is more difficult

to suppress the entire latent image 16 of the original document 100 as shown by a reproduction 100' of the original document 100 in Fig. 16.

Fig. 17 depicts an alternative preferred embodiment of an original document 120 comprising a discrete multi-spectral dynamic camouflaging layer 122. To the extent the particular aspects of the original document 120 are the same as those of the original document 10, the same reference numerals have been used.

The discrete multi-spectral dynamic camouflaging layer 122 comprises thermochromic ink that exhibits multiple colors and densities at any given temperature. The density of the thermochromic ink varies discretely over the discrete multi-spectral dynamic camouflaging layer 122 exhibiting discrete bands 124 of differing colors.

As with the multi-patterned dynamic camouflaging layer 102, the discrete multi-spectral dynamic camouflaging layer 122 enhances the difficulty of the copyist in manipulating the copying device control settings in an attempt to suppress the latent message 16 on a reproduction 120' of the original document 120' as depicted in Fig. 18. That is, because the multiple colored thermochromic ink densities provide differing suppression characteristics, it is more difficult to suppress the entire latent message 16 on the reproduction 120' of the original document 120.

Fig. 19 depicts an alternative preferred embodiment of an original document 140 comprising a prismatic multi-spectral dynamic camouflaging layer 142. To the extent the particular aspects of the original document 140 are the same as those of the original document 10, the same reference numerals have been used.

The prismatic multi-spectral dynamic camouflaging layer 142 differs from the discrete multi-spectral dynamic camouflaging layer 122 in that the colors and density of the thermochromic ink varies continuously, rather than

discretely over the prismatic multi-spectral dynamic camouflaging layer 142 exhibiting a prismatic effect.

As with the discrete multi-spectral dynamic camouflaging layer 122, the prismatic multi-spectral dynamic camouflaging layer 142 enhances the difficulty of the copyist in manipulating the copying device control settings in an attempt to suppress the latent message 16 on a reproduction 140' of the original document 140' as depicted in Fig. 20.

the preferred contrasting layers 14, 52 and 82, and the preferred dynamic camouflaging layers 20, 102, 122, and 142 can be combined in various ways to enhance the protection provided in further alternative preferred embodiments of the present invention.

While embodiments and applications of this invention have been shown and described, it would be apparent, to the readers of this description, that many more modifications are possible without departing from the inventive concepts described herein. The invention, therefore, is not to be restricted beyond the scope and in the spirit of the appended claims.

What is Claimed:

1. A counterfeit-resistant document, comprising:
a substrate;
5 a contrasting layer disposed on said substrate; and
a dynamic camouflaging layer disposed on said
contrasting layer.
2. The counterfeit-resistant document of claim 1,
10 wherein said contrasting layer comprises a message and
a background; and
wherein said dynamic camouflaging layer comprises an
environmentally density changing ink.
- 15 3. The counterfeit-resistant document of claim 1,
wherein said dynamic camouflaging layer comprises a
thermochromic ink.
4. The counterfeit-resistant document of claim 1,
20 wherein said dynamic camouflaging layer comprises a
photochromic ink.
5. The counterfeit-resistant document of claim 2,
wherein said dynamic camouflaging layer comprises a
25 camouflage pattern.
6. The counterfeit-resistant document of claim 5,
wherein said latent message and said background are both
printed in a half-tone.
- 30 7. The counterfeit-resistant document of claim 6,
wherein said document further comprises bearer information.
8. The counterfeit-resistant document of claim 7,
35 wherein said contrasting layer has a line screen value ratio

of at least approximately 2.

9. The counterfeit-resistant document of claim 7,
wherein said contrasting layer has a tonal screen value
5 ratio of at least approximately 1.2.

10. The counterfeit-resistant document of claim 7,
wherein said contrasting layer has a line screen value ratio
greater than two and a tonal screen value ratio greater than
10 1.2.

11. The counterfeit-resistant document of claim 7,
wherein the line screen value of one of said latent message
and said background is at least approximately 50 LPI and the
15 line screen value of another of said latent message and said
background is at most approximately 150 LPI.

12. The counterfeit-resistant document of claim 7,
wherein the tonal screen value of said one of said latent
20 message and said background is at least approximately 8% and
the tonal screen value of said another of said latent
message and said background is at most approximately 5%.

13. The counterfeit-resistant document of claim 10,
25 wherein said one of said latent message and said background
is said latent message and said another of said latent
message and said background is said background.

14. The counterfeit-resistant document of claim 10,
30 wherein said one of said latent message and said background
is said background and said another of said latent message
and said background is said latent message.

15. The counterfeit-resistant document of claim 10,
35 wherein said latent message covers a first area of said

substrate and said background covers a second area of said substrate, said first area being equal to or greater than second area.

5 16. The counterfeit-resistant document of claim 14, wherein said camouflage pattern covers a third area of said substrate and said thermochromic ink of said camouflage pattern covers in area of said substrate equal to or greater than said third area.

10

 17. The counterfeit-resistant document of claim 10, wherein said thermochromic ink has a cold visual density level of between 0.15 and 0.80 and a warm visual density level of between 0.02 and 0.22.

15

 18. The counterfeit-resistant document of claim 17, wherein said thermochromic ink has a cold visual density level of between 0.15 and 0.35 and a warm visual density level of between 0.08 and 0.22.

20

 19. A counterfeit-resistant document, comprising:
a substrate;
a contrasting layer disposed on said substrate; and
a dynamic camouflaging layer disposed on said
25 substrate, said dynamic camouflaging layer comprises an environmentally density changing ink.

30

 20. The counterfeit-resistant document of claim 19, wherein said contrasting layer is a multi-tone contrasting layer.

 21. The counterfeit-resistant document of claim 20, wherein said multi-tone contrasting layer comprises a first contrasting portion and a second contrasting portion, said
35 first contrasting portion comprising a first latent message

and a first background, said second contrasting portion comprising a second latent message and a second background.

22. The counterfeit-resistant document of claim 21,
5 wherein said first latent message, said second latent message, said first background, and said second background are printed in half-tone, said first latent message has a first latent message tonal screen value and said second
10 latent message has a second latent message tonal screen value, and said first latent message tonal screen value is greater than said second latent message tonal screen value.

23. The counterfeit-resistant document of claim 22,
15 wherein said first background has a first background tonal screen value and said second background has a second background tonal screen value, and said first background tonal screen value is greater than said second background tonal screen value.

20 24. The counterfeit-resistant document of claim 22, wherein said first latent message has a first latent message line screen value, said second latent message has a second latent message line screen value, said first background has a first background line screen value and a first background
25 tonal value, and said second background has a second background line screen value and a second background tonal value, said first latent message line screen value differing from said first background message line screen value, and said second latent message line screen value differing from
30 said second background line screen value.

25. The counterfeit-resistant document of claim 24,
wherein said first latent message tonal value is greater than said first background tonal value, said first latent
35 message line screen value is less than said first background

line screen value, said second latent message tonal value is greater than said second background tonal value, and said second latent message line screen value is less than said second background line screen value.

5

26. The counterfeit-resistant document of claim 19, wherein said contrasting layer is a vignetted contrasting layer.

10

27. The counterfeit-resistant document of claim 26, wherein said vignetted contrasting layer comprises a latent message and a background, and one of said latent message and said background having a tonal screen value that varies gradually across said vignetted contrasting layer.

15

28. The counterfeit-resistant document of claim 27, wherein said one of said latent message and said background has a line screen value that is uniform across said vignetted contrasting layer.

20

29. The counterfeit-resistant document of claim 28, wherein said tonal screen value varies from between 30% and 20% to between 15% and 5% across said vignetted contrasting layer.

25

30. The counterfeit-resistant document of claim 29, wherein said one of said latent message and said background is said latent message.

30

31. The counterfeit-resistant document of claim 19, wherein said dynamic camouflaging layer is a multi-patterned dynamic camouflaging layer.

35

32. The counterfeit-resistant document of claim 31, wherein said multi-patterned dynamic camouflaging layer

comprises at least three distinct camouflage patterns.

33. The counterfeit-resistant document of claim 19,
wherein said dynamic camouflaging layer is a multi-spectral
5 dynamic camouflaging layer.

34. The counterfeit-resistant document of claim 33,
wherein said multi-spectral dynamic camouflaging layer
comprises thermochromic ink that exhibits multiple densities
10 at a given temperature.

35. The counterfeit-resistant document of claim 34,
wherein said multi-spectral dynamic camouflaging layer is a
discrete multi-spectral dynamic camouflaging layer.
15

36. The counterfeit-resistant document of claim 34,
wherein said multi-spectral dynamic camouflaging layer is a
prismatic multi-spectral dynamic camouflaging layer.

20 37. A method of creating a counterfeit-resistant
document, the method comprising the steps:
selecting a pattern for a contrasting layer;
selecting a pattern for a dynamic camouflaging layer;
applying said contrasting layer pattern to said
25 substrate to create a contrasting layer on said substrate;
and
applying said dynamic camouflaging pattern to said
contrasting layer to create a dynamic camouflaging layer.

30 38. The method of claim 37, wherein said contrasting
layer pattern and said dynamic camouflaging layer pattern
are selected such that a latent message is suppressed on
said document and said latent message is exhibited on a
reproduction of said document.

35 39. The method of claim 38, wherein said contrasting
layer selection step comprises selecting said latent message

and a background, such that said latent message is exhibited on said reproduction over a wide range of copying device control settings.

5 40. The method of claim 39, wherein said dynamic camouflaging layer selection step further comprises selecting a thermochromic ink having a visual density that inversely varies with temperature.

10 41. The method of claim 40, wherein said thermochromic ink has a cold density, such that said dynamic camouflaging layer is inactivated at room temperatures, and a warm density, such that said dynamic camouflaging layer is activated at scanning temperatures.

15

 42. The method of claim 41, wherein said dynamic camouflaging layer selection step further comprises selecting a camouflage pattern.

20 43. The method of claim 42, further comprising the step of applying bearer information to said substrate.

AMENDED CLAIMS

[received by the International Bureau on 16 August 1999 (16.08.99);
original claims 2, 8-14, 22, 26, 33 and 39 amended; remaining claims
unchanged (7 pages)]

What is Claimed

1. A counterfeit-resistant document, comprising:
a substrate;
a contrasting layer disposed on said substrate; and
5 a dynamic camouflaging layer disposed on said contrasting layer.
2. The counterfeit-resistant document of claim 1,
wherein said contrasting layer comprises a latent message and a background; and
wherein said dynamic camouflaging layer comprises an environmentally density
10 changing ink.
3. The counterfeit-resistant document of claim 1, wherein said dynamic
camouflaging layer comprises a thermochromic ink.
- 15 4. The counterfeit-resistant document of claim 1, wherein said dynamic
camouflaging layer comprises a photochromic ink.
5. The counterfeit-resistant document of claim 2, wherein said dynamic
camouflaging layer comprises a camouflage pattern.
- 20 6. The counterfeit-resistant document of claim 5, wherein said latent message
and said background are both printed in a half-tone.
7. The counterfeit-resistant document of claim 6, wherein said document further
25 comprises bearer information.
8. The counterfeit-resistant document of claim 7, wherein said contrasting layer has a
line screen value ratio of at least 2.
- 30 9. The counterfeit-resistant document of claim 7, wherein said contrasting layer has a
tonal screen value ratio of at least 1.2.

10. A counterfeit-resistant document, comprising:

a substrate;

a contrasting layer disposed on said substrate, said contrasting layer comprising a latent message and a background both printed in a half-tone, wherein said contrasting layer
5 has a line screen value ratio greater than two and a tonal screen value ratio greater than 1.2;
and

a dynamic camouflaging layer disposed on said contrasting layer, said dynamic camouflaging layer comprising an environmentally density changing ink formed in a camouflage pattern.

10

11. The counterfeit-resistant document of claim 7, wherein the line screen value of one of said latent message and said background is at least 50 LPI and the line screen value of another of said latent message and said background is at most 150 LPI.

15

12. The counterfeit-resistant document of claim 7, wherein the tonal screen value of said one of said latent message and said background is at least 8% and the tonal screen value of said another of said latent message and said background is at most 5%.

20

13. The counterfeit-resistant document of claim 7, wherein said latent message has a tonal value of at least 8% and said background has a tonal value of at most 5%.

14. The counterfeit-resistant document of claim 7, wherein said background has a tonal value of at least 8% and said latent message has a tonal value of at most 5%.

25

15. The counterfeit-resistant document of claim 10, wherein said latent message covers a first area of said substrate and said background covers a second area of said substrate, said first area being equal to or greater than second area.

30

16. The counterfeit-resistant document of claim 14, wherein said camouflage pattern covers a third area of said substrate and said thermochromic ink of said camouflage pattern covers in area of said substrate equal to or greater than said third area.

17. The counterfeit-resistant document of claim 10, wherein said thermochromic ink has a cold visual density level of between 0.15 and 0.80 and a warm visual density level of between 0.02 and 0.22.

5 18. The counterfeit-resistant document of claim 17, wherein said thermochromic ink has a cold visual density level of between 0.15 and 0.35 and a warm visual density level of between 0.08 and 0.22.

10 19. A counterfeit-resistant document, comprising:
a substrate;
a contrasting layer disposed on said substrate; and
a dynamic camouflaging layer disposed on said substrate, said dynamic camouflaging layer comprises an environmentally density changing ink.

15 20. The counterfeit-resistant document of claim 19, wherein said contrasting layer is a multi-tone contrasting layer.

20 21. The counterfeit-resistant document of claim 20, wherein said multi-tone contrasting layer comprises a first contrasting portion and a second contrasting portion, said first contrasting portion comprising a first latent message and a first background, said second contrasting portion comprising a second latent message and a second background.

25 22. A counterfeit-resistant document, comprising:
a substrate;
a multi-tone contrasting layer disposed on said substrate, said multi-tone contrasting layer comprising a first contrasting portion and a second contrasting portion, said first contrasting portion comprising a first latent message and a first background both printed in a half-tone, said second contrasting portion comprising a second latent message and a second background both printed in a half-tone, said first latent message having a first latent message tonal screen value and said second latent message having a second latent message tonal screen value, and said first latent message tonal screen value being greater than said second latent message tonal screen value; and

30

a dynamic camouflaging layer disposed on said substrate, said dynamic camouflaging layer comprising an environmentally density changing ink.

23. The counterfeit-resistant document of claim 22, wherein said first
5 background has a first background tonal screen value and said second background has a second background tonal screen value, and said first background tonal screen value is greater than said second background tonal screen value.

24. The counterfeit-resistant document of claim 22, wherein said first latent
10 message has a first latent message line screen value, said second latent message has a second latent message line screen value, said first background has a first background line screen value and a first background tonal value, and said second background has a second background line screen value and a second background tonal value, said first latent message line screen value differing from said first background message line screen value, and said
15 second latent message line screen value differing from said second background line screen value.

25. The counterfeit-resistant document of claim 24, wherein said first latent message tonal value is greater than said first background tonal value, said first latent
20 message line screen value is less than said first background line screen value, said second latent message tonal value is greater than said second background tonal value, and said second latent message line screen value is less than said second background line screen value.

25 26. A counterfeit-resistant document, comprising:
a substrate;
a vignetted contrasting layer disposed on said substrate; and
a dynamic camouflaging layer disposed on said substrate, said dynamic
camouflaging layer comprising an environmentally density changing ink.

30

27. The counterfeit-resistant document of claim 26, wherein said vignetted contrasting layer comprises a latent message and a background, and one of said latent

message and said background having a tonal screen value that varies gradually across said vignetted contrasting layer.

28. The counterfeit-resistant document of claim 27, wherein said one of said
5 latent message and said background has a line screen value that is uniform across said vignetted contrasting layer.

29. The counterfeit-resistant document of claim 28, wherein said tonal screen
value varies from between 30% and 20% to between 15% and 5% across said vignetted
10 contrasting layer.

30. The counterfeit-resistant document of claim 29, wherein said one of said
latent message and said background is said latent message.

31. The counterfeit-resistant document of claim 19, wherein said dynamic
camouflaging layer is a multi-patterned dynamic camouflaging layer.

32. The counterfeit-resistant document of claim 31, wherein said multi-patterned
dynamic camouflaging layer comprises at least three distinct camouflage patterns.

33. A counterfeit-resistant document, comprising:
a substrate;
a contrasting layer disposed on said substrate; and
a multi-spectral dynamic camouflaging layer disposed on said substrate, said multi-
25 spectral dynamic camouflaging layer comprising an environmentally density changing ink.

34. The counterfeit-resistant document of claim 33, wherein said multi-spectral
dynamic camouflaging layer comprises thermochromic ink that exhibits multiple densities at
a given temperature.

35. The counterfeit-resistant document of claim 34, wherein said multi-spectral
dynamic camouflaging layer is a discrete multi-spectral dynamic camouflaging layer.

36. The counterfeit-resistant document of claim 34, wherein said multi-spectral dynamic camouflaging layer is a prismatic multi-spectral dynamic camouflaging layer.

5 37. A method of creating a counterfeit-resistant document, the method comprising the steps:
 selecting a pattern for a contrasting layer;
 selecting a pattern for a dynamic camouflaging layer;
 applying said contrasting layer pattern to said substrate to create a contrasting layer
10 on said substrate; and
 applying said dynamic camouflaging pattern to said contrasting layer to create a dynamic camouflaging layer.

 38. The method of claim 37, wherein said contrasting layer pattern and said
15 dynamic camouflaging layer pattern are selected such that a latent message is suppressed on said document and said latent message is exhibited on a reproduction of said document.

 39. The method of claim 38, wherein said contrasting layer selection step comprises selecting said latent message and a background, such that said latent message is exhibited on
20 said reproduction over a copying range including the highest and lowest copying device control settings, wherein said reproduction is an acceptable and discernible reproduction of said document.

 40. The method of claim 39, wherein said dynamic camouflaging layer selection
25 step further comprises selecting a thermochromic ink having a visual density that inversely varies with temperature.

 41. The method of claim 40, wherein said thermochromic ink has a cold density, such that said dynamic camouflaging layer is inactivated at room temperatures, and a warm
30 density, such that said dynamic camouflaging layer is activated at scanning temperatures.

42. The method of claim 41, wherein said dynamic camouflaging layer selection step further comprises selecting a camouflage pattern.

43. The method of claim 42, further comprising the step of applying bearer
5 information to said substrate.

STATEMENT UNDER ARTICLE 19(1)

The International Search Report issued by the ISA indicates that the inventions claimed in claims 1-3, 5, 19, 21 and 37-43 cannot be considered novel or cannot be considered to involve an inventive step when U.S. Patent No. 5,873,604 to Phillips (hereinafter, "'604 patent'") is taken alone. The '604 patent, however, did not issue prior to the prior date of the present application. Specifically, the '604 patent issued February 23, 1999, whereas the priority date of the present application is March 23, 1998. Thus, the '604 patent is not prior art to the present application.

FIG. 1

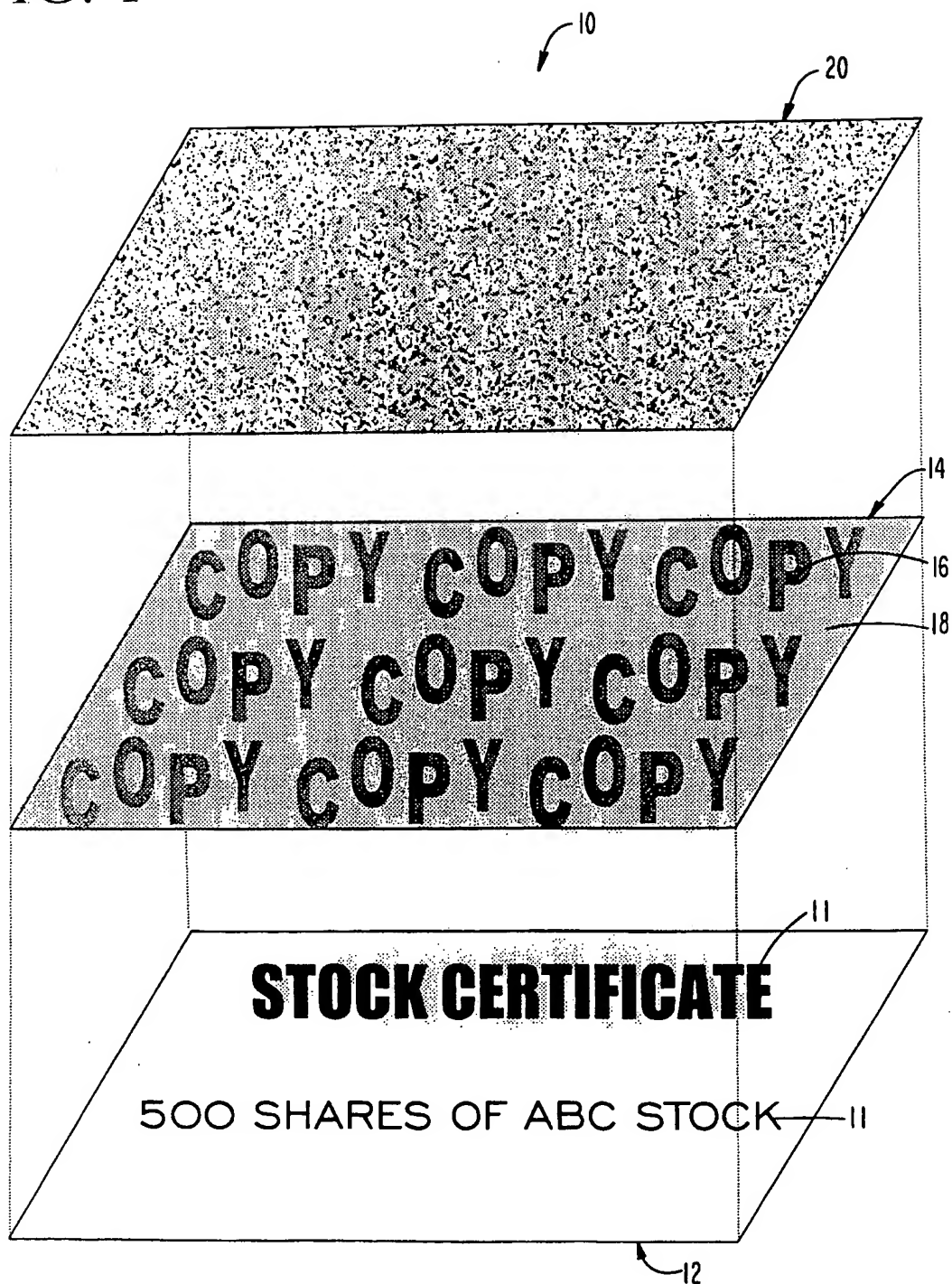


FIG. 2

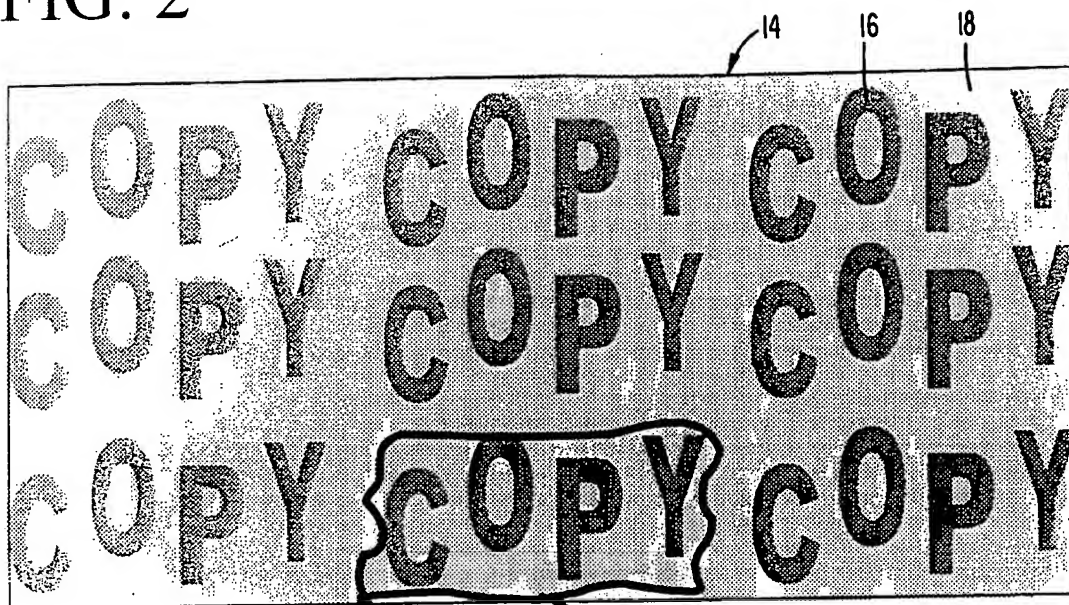


FIG. 2A

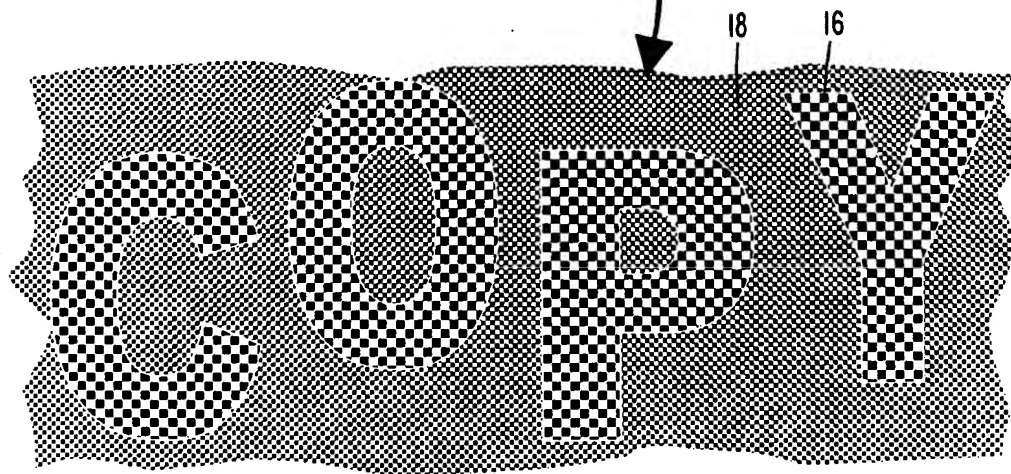


FIG. 3A

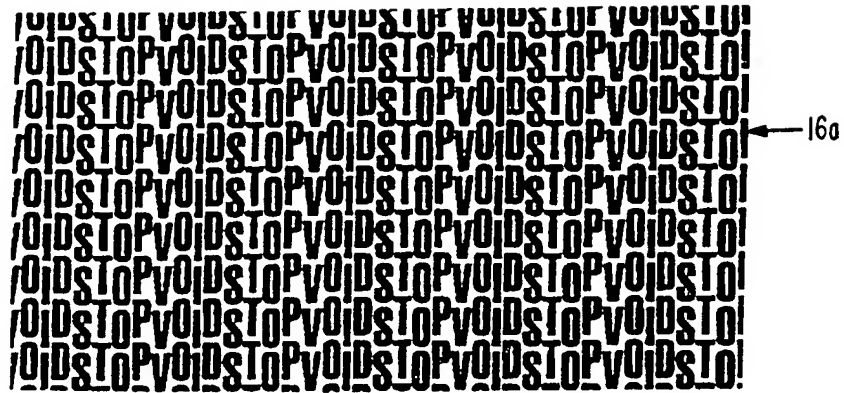


FIG. 3B

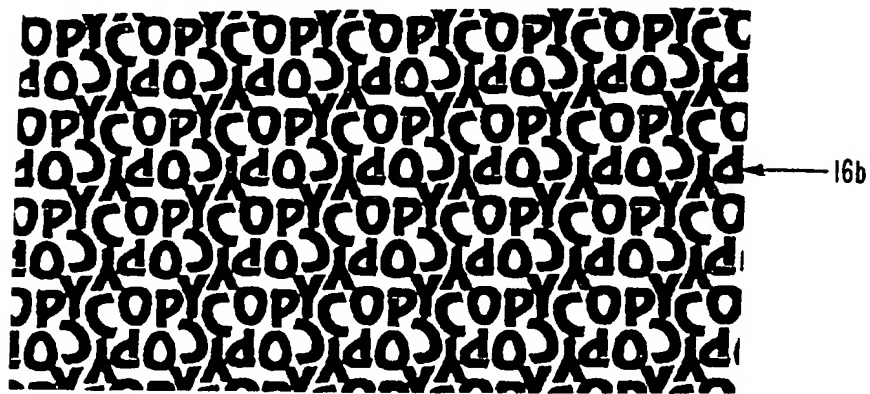


FIG. 3C

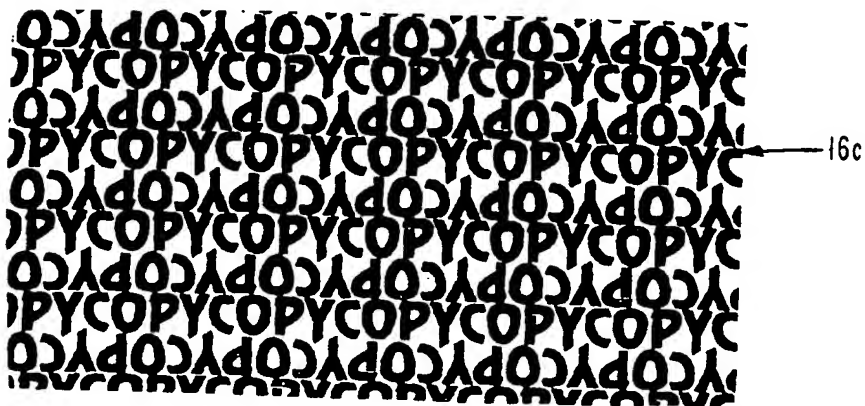
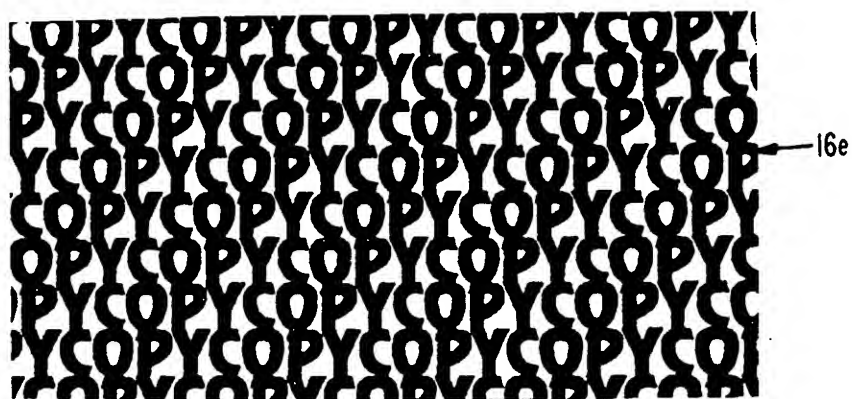


FIG. 3D

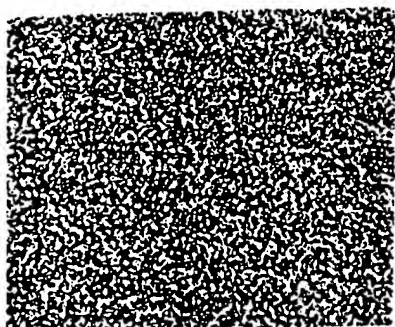


FIG. 3E



5/15

FIG. 4A.



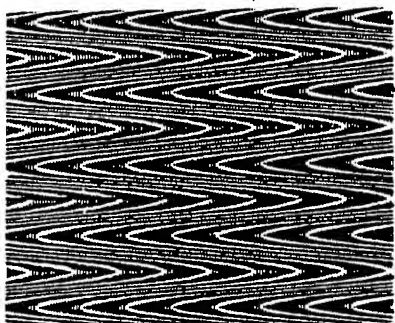
22a

FIG. 4E.



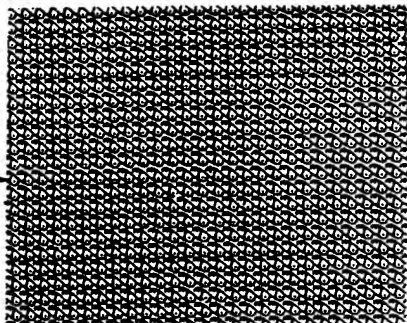
22e

FIG. 4B.



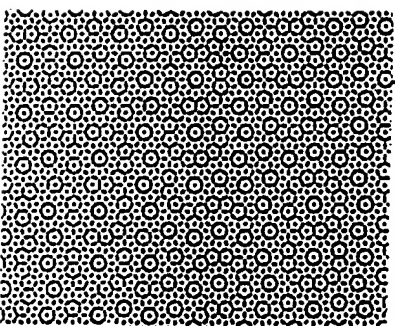
22b

FIG. 4F.



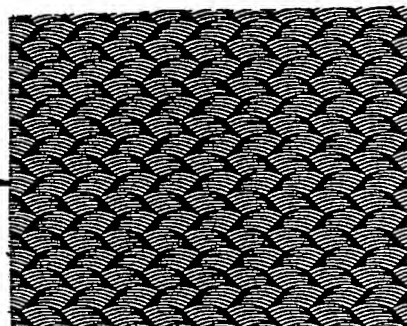
22f

FIG. 4C.



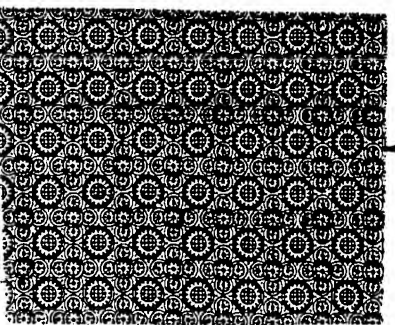
22c

FIG. 4G.



22g

FIG. 4D.



22d

6/15

FIG. 5.

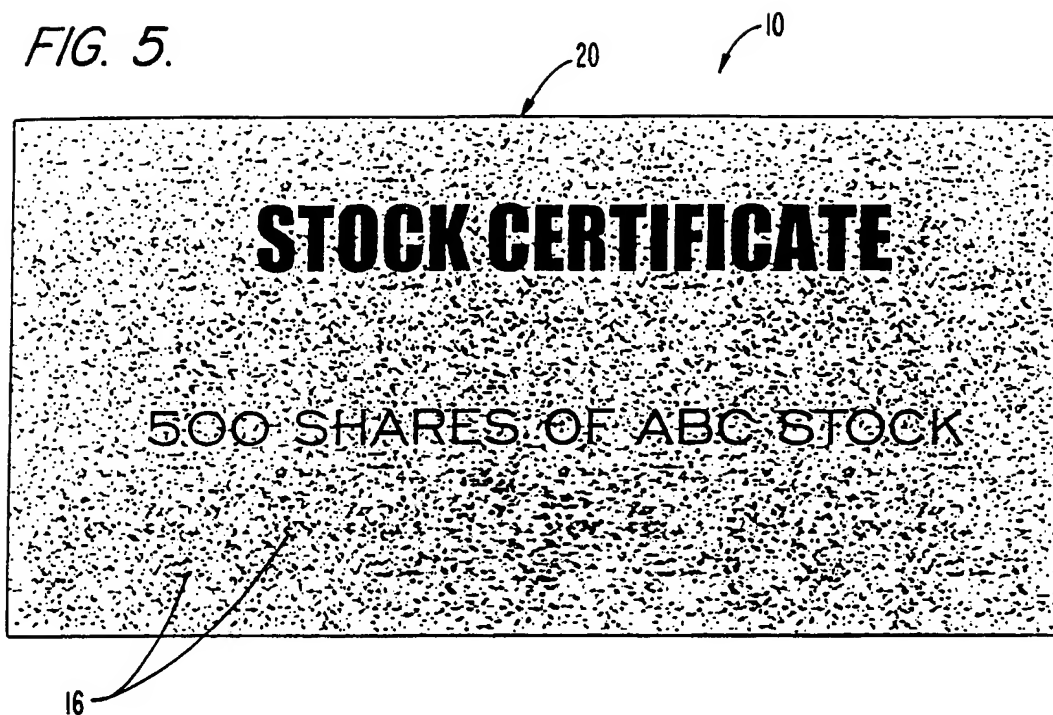
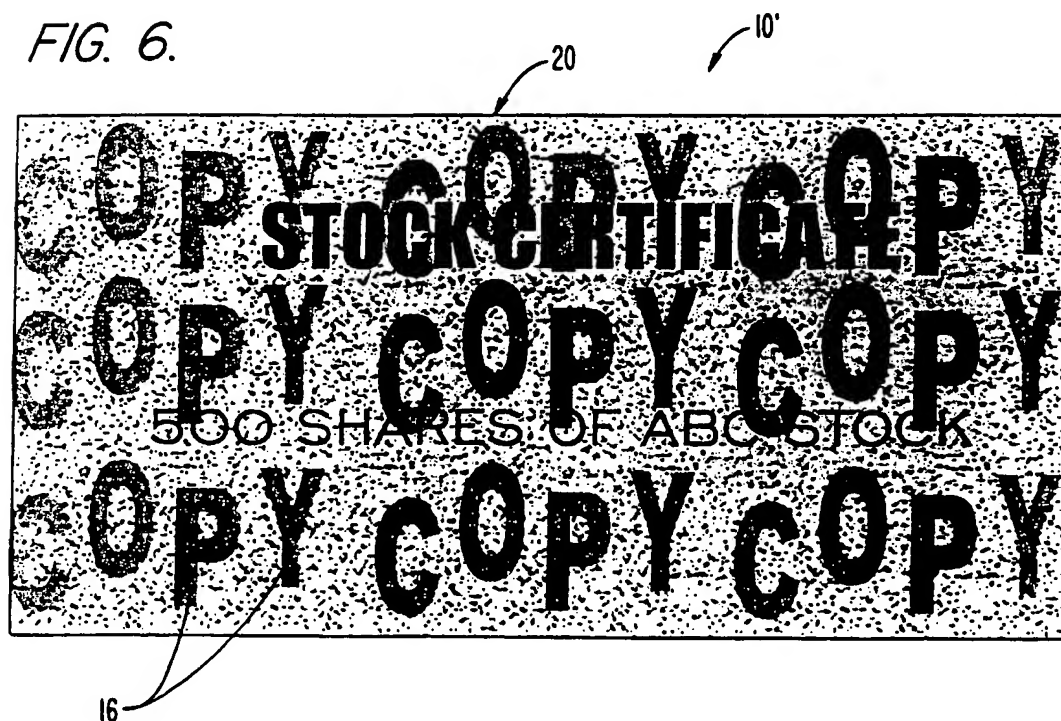
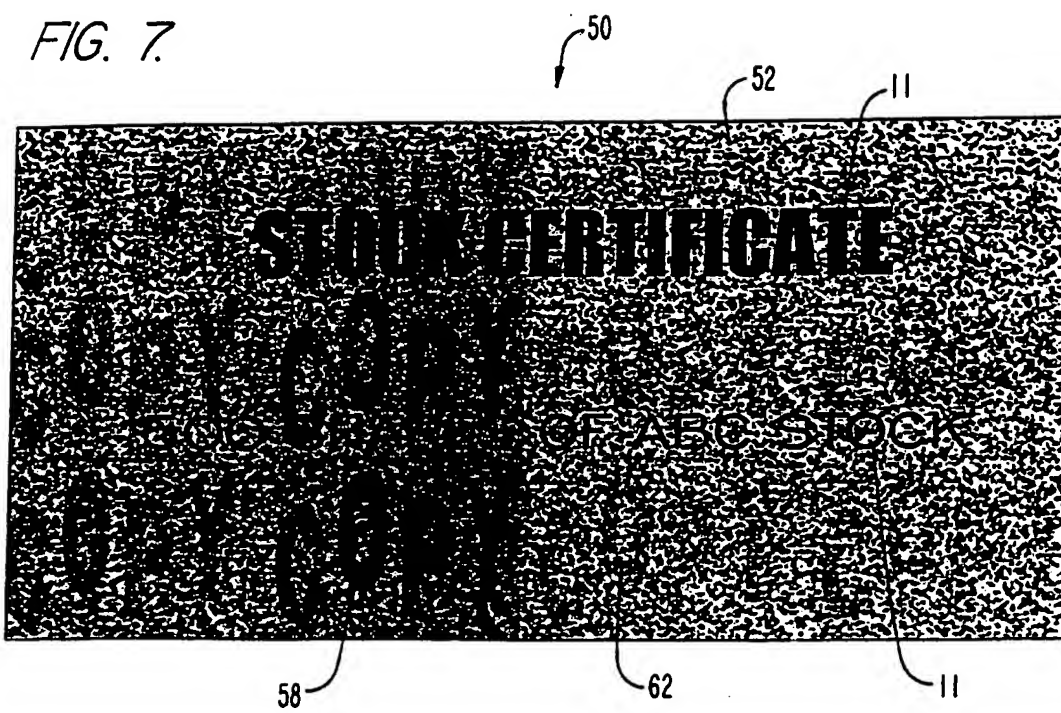


FIG. 6.



7/15

FIG. 7.



8/15

FIG. 8.

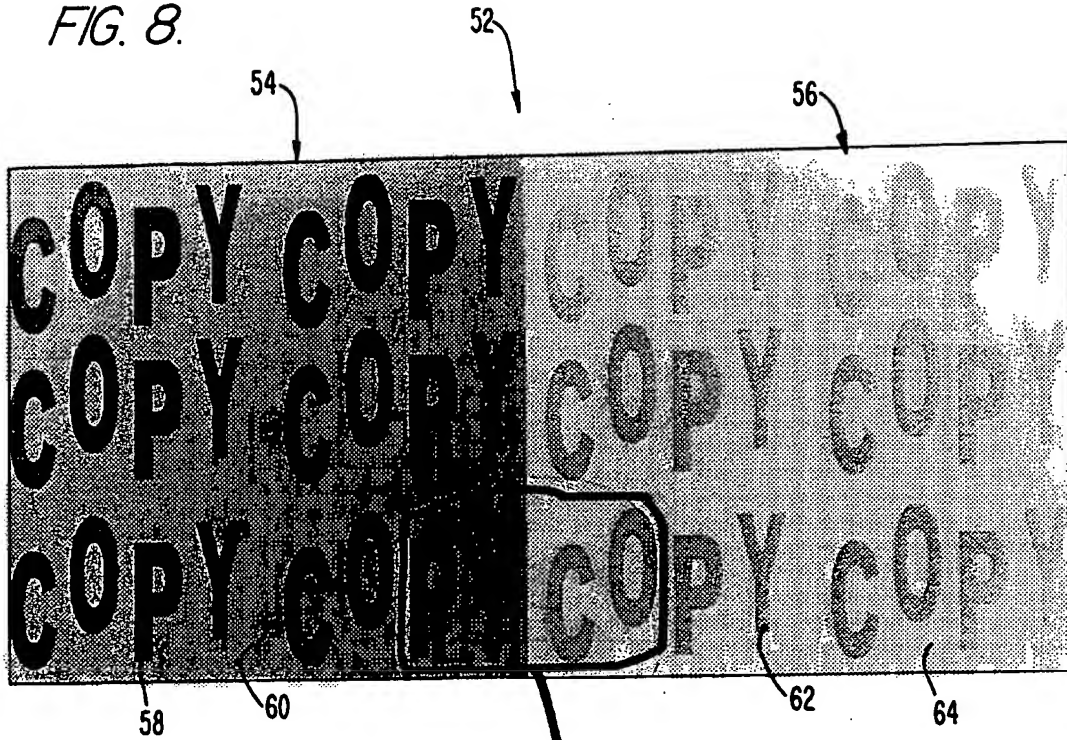
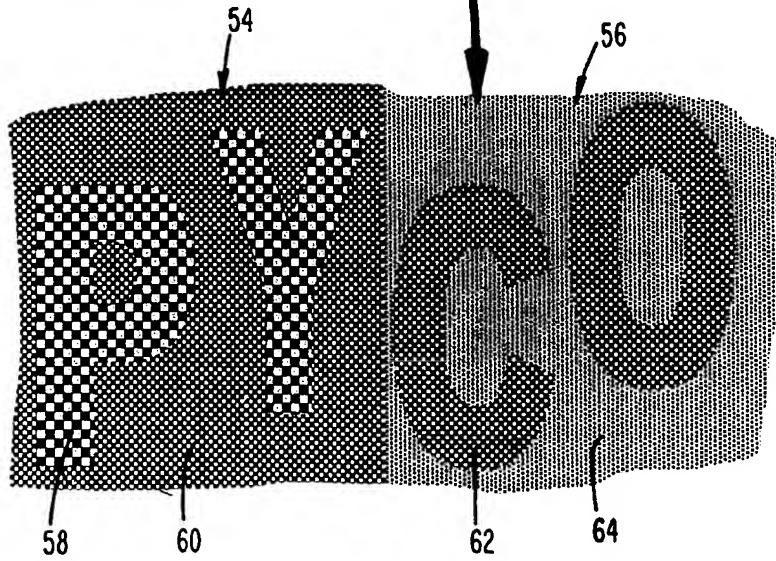


FIG. 8A.



9/15

FIG. 9.

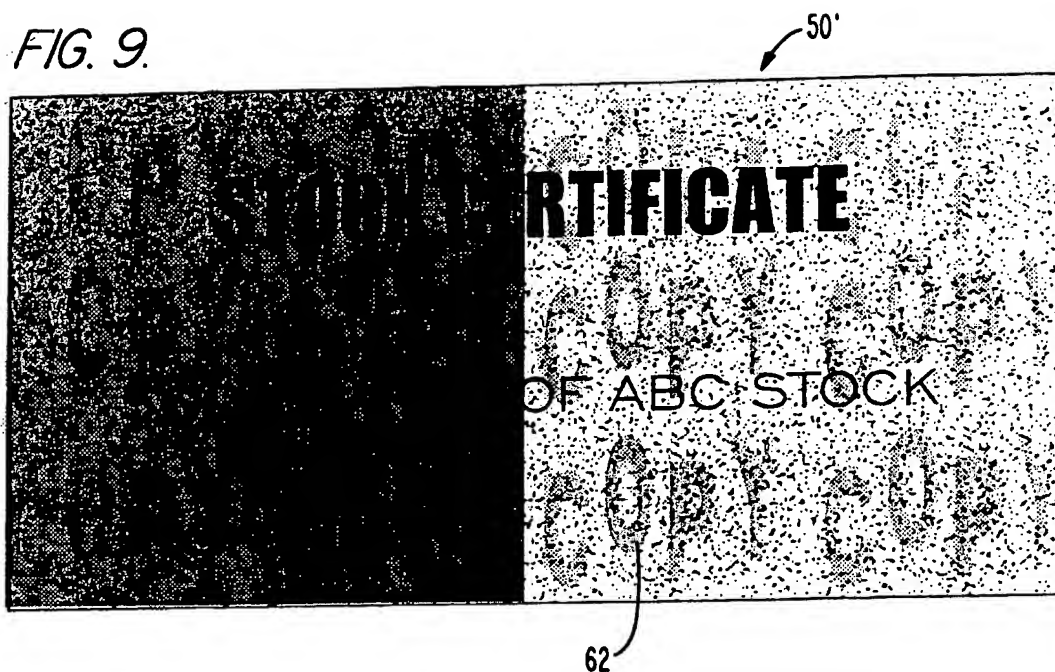
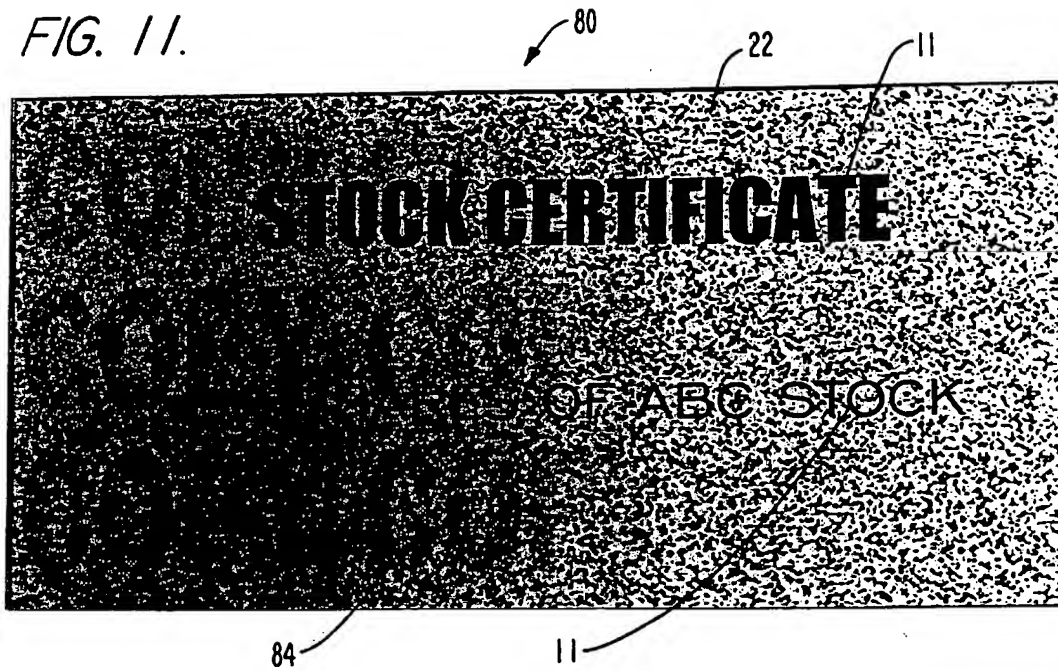


FIG. 10.



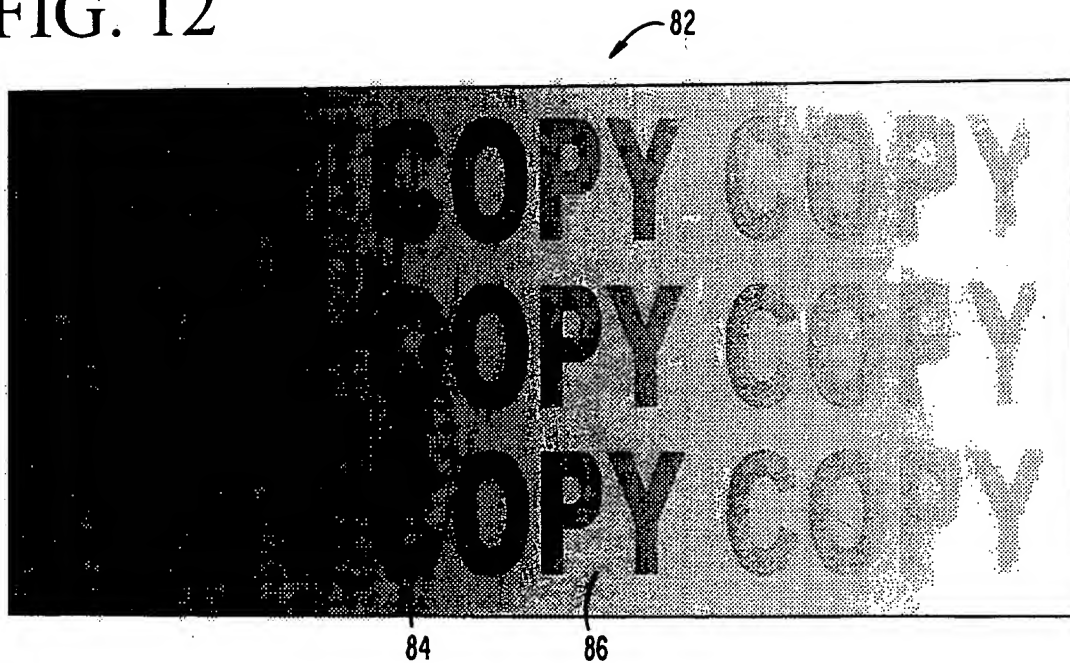
10/15

FIG. 11.



11/15

FIG. 12



12/15

FIG. 13.

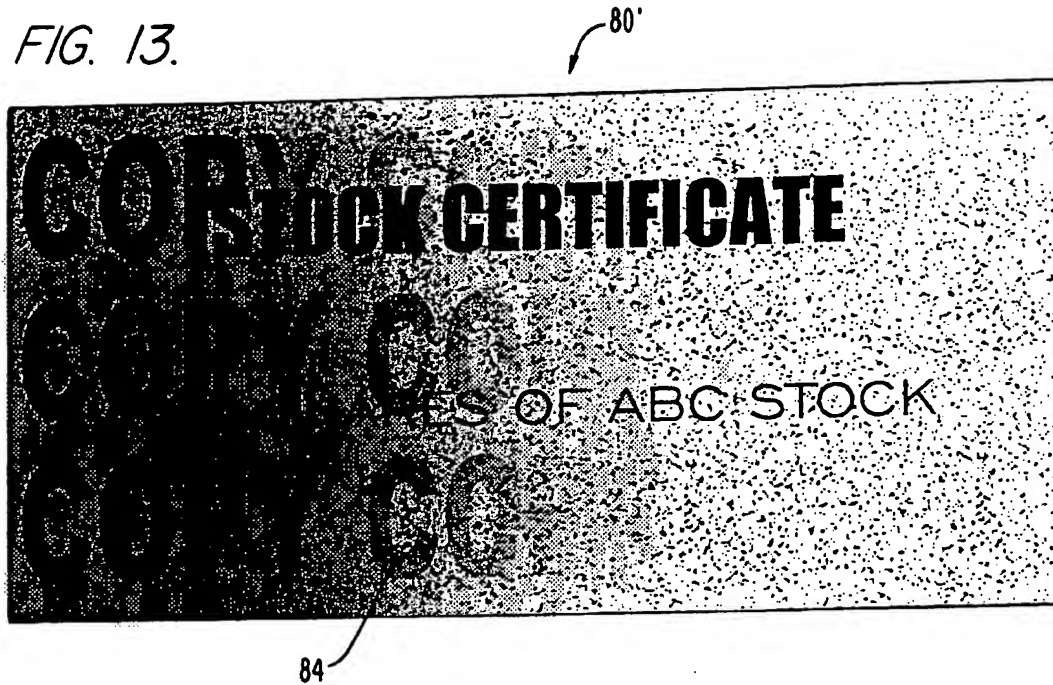


FIG. 14.



13/15

FIG. 15.

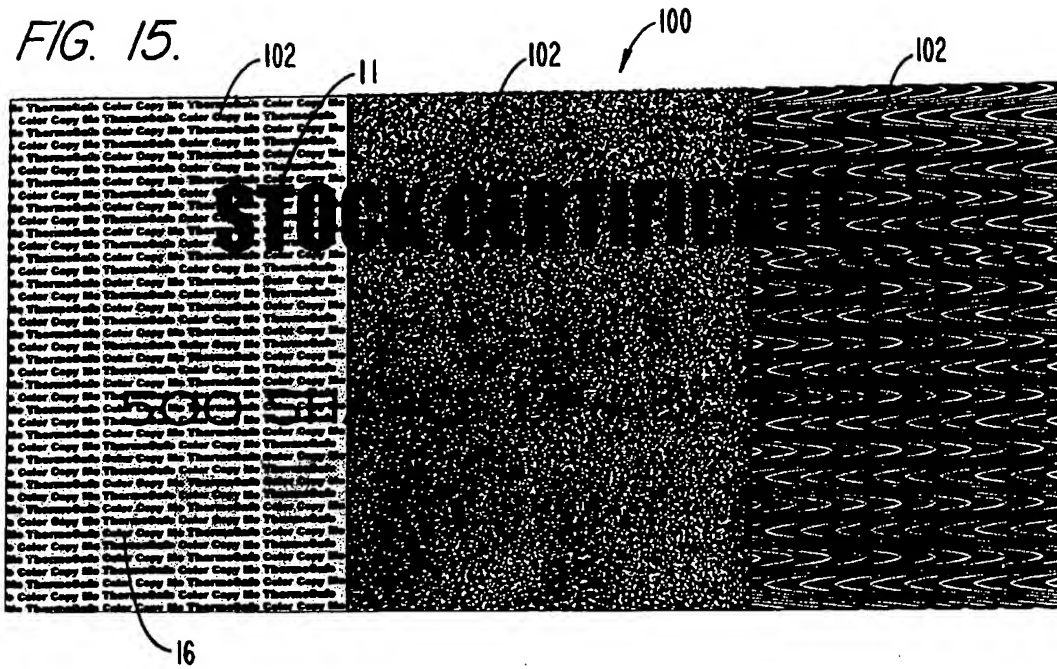
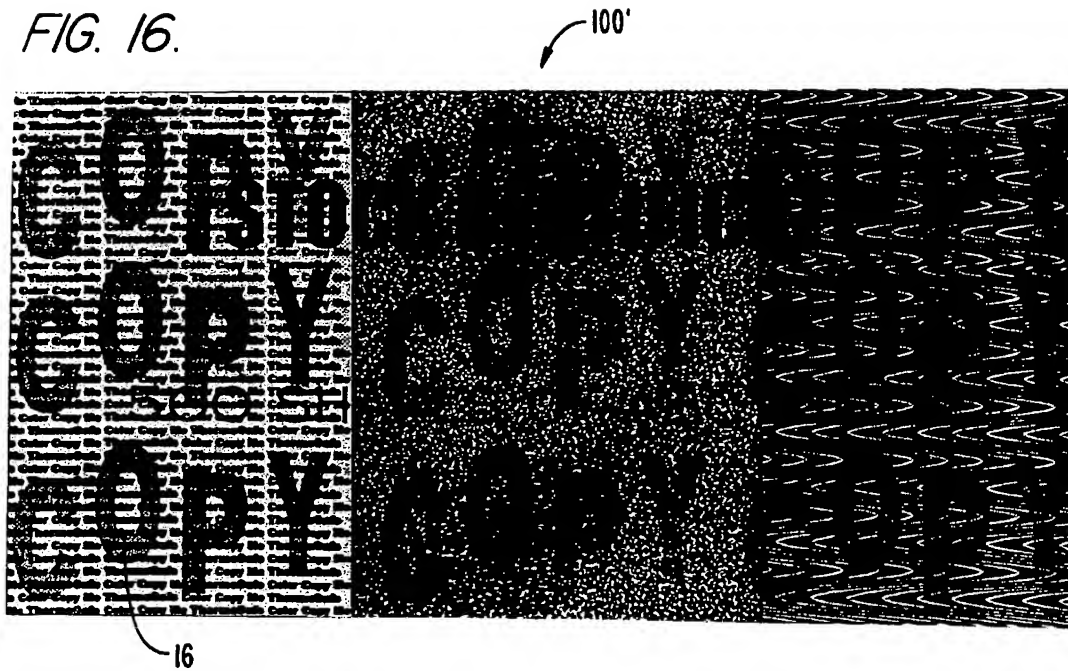


FIG. 16.



14/15

FIG. 17.

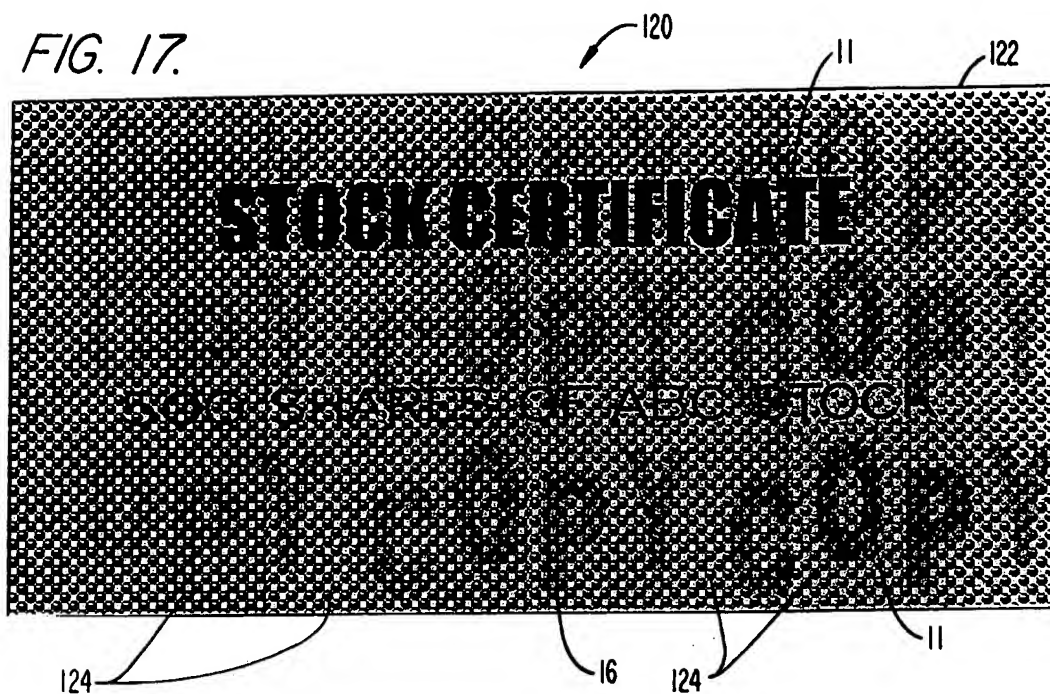
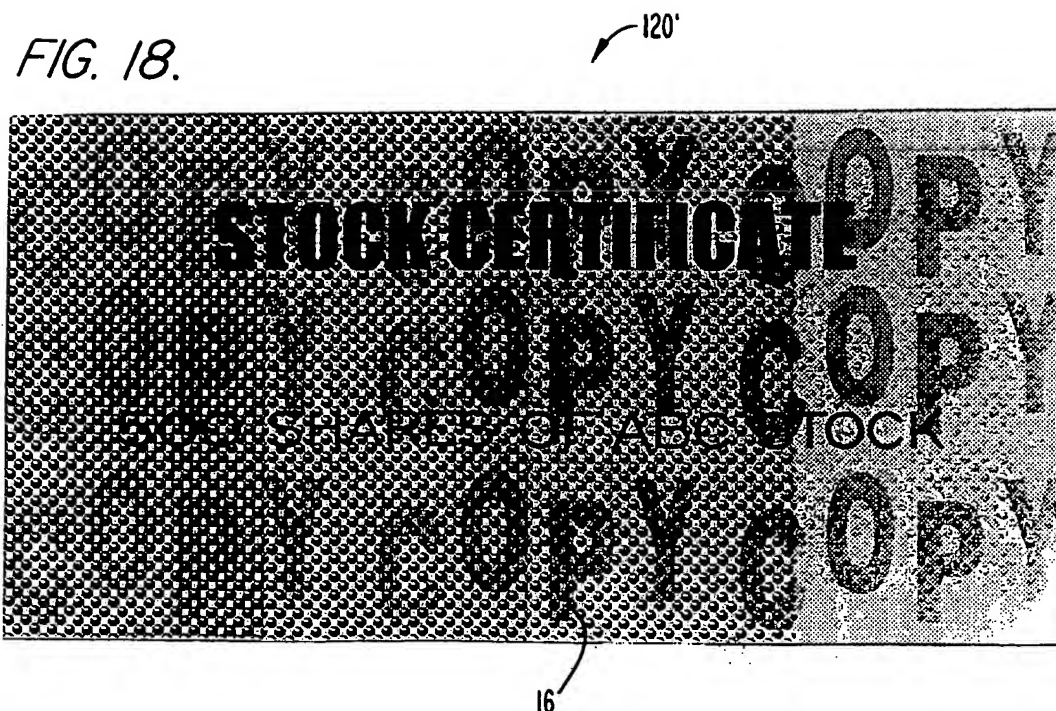


FIG. 18.



15/15

FIG. 19.

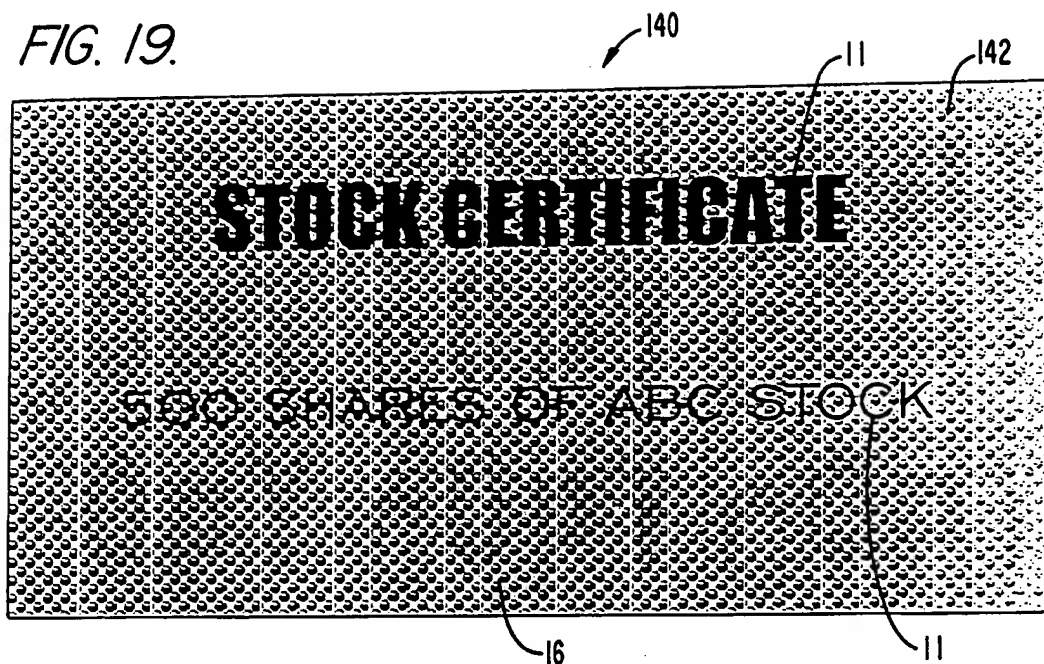
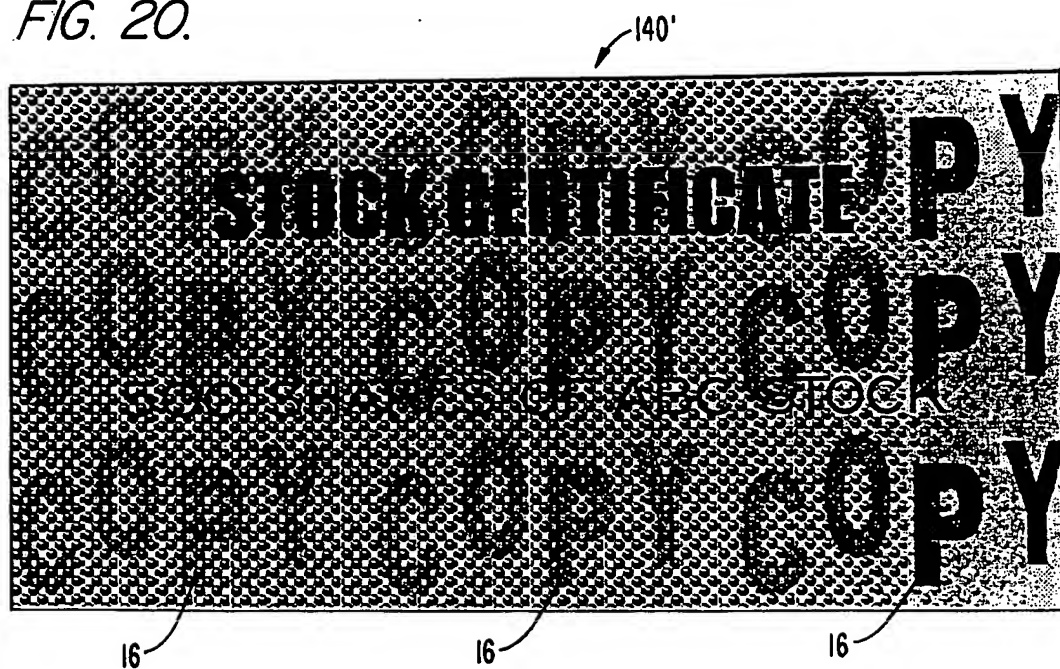


FIG. 20.



INTERNATIONAL SEARCH REPORT

 International application No.
PCT/US99/05988

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : B42D 15/00

US CL : 283/70

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 5,873,604 A [PHILLIPS] 23 February 1999, col. 4 lines 51-53, col. 5 lines 10-14, lines 36-52, col. 6 lines 66-67, col. 7 lines 1, fig. 1, fig. 2 items 6,7	1-3,5,19,21,37-43 ----- 4,6-8,11,20,31,32
Y	US 4,927,180 A [TRUNDLE] 22 May 1990, AB, col. 1 lines 1-14	4
Y	US 4,310,180 A [MOWRY, JR.] 12 January 1982, col. 3 lines 14-35, col. 5 lines 38-40, col 6 lines 5-9	6,7,8,11,20,31,32
A	US 4,632,429 A (GARDNER ET AL.) 30 December 1986, see entire document	1-43

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search

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 Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-0040

Authorized officer

PAUL E. CALLAHAN

Telephone No. (703) 305-1336

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/05988

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,463,970 A [KAULE ET AL.] 07 August 1984, see entire document	1-43
A	US 5,372,387 A [WAJDA] 13 December 1994, see entire document	1-43
A	US 5,516,362 A [GUNDJIAN] 14 May 1996, see entire document	1-43
A	US 5,087,507 [HEINZER] 11 February 1992, see entire document	1-43

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/05988

B. FIELDS SEARCHED

Minimum documentation searched

Classification System: U.S.

283/70,72,73,91,92,93,94,902,67; 430/10; 162/140; 427/7; 101/490,491; 106/31.01,31.13;
427/144,145,272,259,282; 380/54,51